MANIPULATIONS IN THE SCIENTIFIC ARTS.

PHOTOGENIC MANIPULATION:

PART I.

CONTAINING

THE THEORY AND PLAIN INSTRUCTIONS

IN THE ART OF

PHOTOGRAPHY,

OR

THE PRODUCTION OF PICTURES THROUGH THE AGENCY OF LIGHT:

INCLUDING

CALOTYPE, CHRYSOTYPE, CYANOTYPE, CHROMATYPE, ENERGIATYPE, ANTHOTYPE,

AND AMPHITYPE.

BY

GEORGE THOMAS FISHER, JUN.

ASSISTANT IN THE LABORATORY OF THE LONDON INSTITUTION.

Illustrated by Wood Cuts.

SECOND EDITION.

LONDON:

PUBLISHED BY GEORGE KNIGHT AND SONS,

MANUFACTURERS OF CHEMICAL APPARATUS AND PHILOSOPHICAL INSTRUMENTS,

FOSTER-LANE, CHEAPSIDE

Price One Shilling.

Printed by STEWART and MURRAY, Old Bailey.

W. Tite Esqr F.R.S.
from his obliged & obedient
Servant
George Thomas Fisher

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PART III.

PHOTOGENIC MANIPULATION.

Francis Bedford. 1846.

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PREFACE.

The First Edition of this little manual has been for a considerable time exhausted, and although constant demands have been made for it,—a circumstance only to be attributed to the interest of the subject,—it was determined, that although more time would necessarily be consumed in the compilation, every exertion should be made to render the Second Edition as complete a record as possible of the numerous processes of the interesting science on which it treats.

In preparing the materials for the new Edition, it was found that it would be impossible to give within the necessary limits even a brief outline of many of the most interesting processes and phenomena connected with this science, to which, at the last meeting of the British Association, the term Actino-Chemistry has been given. Rather, therefore, than abridge or omit, and thus render the manual imperfect, it was determined to divide the work into Two Parts, the first

portion being devoted to the consideration of all the photographic processes as applied to paper, and the second part being descriptive of the Daguerreotype, Thermography, Electrical and Galvanic Impressions.

We trust that it may not be deemed out of place, if we venture to make a few remarks on the value of the discoveries recorded in this little work. Many persons are still disposed to doubt their utility, and to ask, on all occasions, the question, *cui bono?* Independently of the extent to which we are justified in anticipating that it will spread, and the advantage which may accrue from future discoveries, even now its great value is, we believe, manifest. All men of reading desire to possess faithful representations of the monuments of antiquity—the Pyramids of Gizeh, the palaces or the temples of Ancient Greece and Rome. Every one must feel a pure and healthful pleasure in contemplating the representations of scenes made sacred to our memory by the deeds of heroes, or the words of sages. The temples of Athens, the wonderful Acropolis, the mysterious ruins of Pæstum, and the fanes and arches of Rome, proudly but vainly named the eternal, speak even from their pictures. Theirs is the still small voice of the past speaking of the mutability of all things to the present. The lesson they thus give us, even those who have never crossed the sea which washes our island home, is but little inferior to that which the traveller receives who contemplates the moral of a crumbling arch or a broken column, on

the very spots where once they stood the glory of the age. Even in our own land we have temples which realize, in their consistent and beautifully elaborate architectural details, the poet's fancy of a "petrified religion." We have monastic piles hastening to decay, but beautiful even in their dissolution, and baronial halls whose battlemented walls are tangled with the ivy and clothed with the moss of centuries; and these are hallowed by holy recollections which cling like the poetry of a pious superstition to every heart; and they cannot pass away until we have forgotten the history of our own land. Each and all of these we are now enable to preserve in the strictest fidelity. Every stone will tell its own tale; and as the mind of the poet shines for ever from his productions, so the very genius, the very spirit of the place, may now be impressed by the subtle fingers of light upon tablets of metal or sheets of paper, to speak to future ages as they speak to us. Again, by this wondrous science, we are now enabled to preserve and hand down to future generations the *truth-telling* portraits of our statesmen, our heroes, our philosophers, our poets, and our friends, with "all the mind, the music breathing through the face."

But, independently of this practical utility, we have derived another advantage from the discoveries which have been made in this branch of science. We have been enabled to perceive and contemplate the beauty and harmony of those laws by which Divine Wisdom

regulates and governs the universe. They have shown us that not a sunbeam can fall without producing a molecular or chemical change. They have taught us how close is the tie which exists between all the imponderables, light, heat, electricity, &c. They have proved to us how necessary to organic life, to the germination and growth of plants, the vitality and welfare of the animal creation, is that "efflux divine," of which it has been poetically and truly said that "balm, and joy, and life is in its ray."

GEORGE THOMAS FISHER.

London Institution,
Feb. 1845.

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PHOTOGENIC MANIPULATION.

I. INTRODUCTORY REMARKS.

1. It is not the intention of the author of this little treatise to enter into a philosophical detail of the laws on which the wondrous art of Photography is based, but rather to explain, clearly and distinctly, the various steps necessary to be taken by the experimenter in order to ensure success, dwelling more particularly on those minor points which so materially affect the result of all experiments, and without attention to which failure will be the inevitable result. The work is written solely for the instruction of the amateur, and is therefore divested as much as possible of all technicalities, while at the same time care has been taken to recommend only those processes which are the most likely to be attended with success.

2. Photography,* or as ti is also termed, photogenic † drawing, is, as its name indicates, the art of producing pictures by the agency of light, and may undoubtedly be ranked amongst the most pleasing and curious results of chemical philosophy, nor is it the least useful. Every one who has seen the pretty philosophical toy, the camera obscura, must needs have admired the minutely perfect reflection of the landscape or any other object brought within its view, although this admiration must have been accompanied by a

* From φως light, and γραφω to write, to depict.
† From φως light, and γενναω to produce.

feeling of regret that it was only a shadow doomed but to last for a moment. Photography, however, and especially those modifications of it which we shall hereafter have to describe, the Calotype and Daguerreotype, enable us to fix "the fleeting shadows as they pass," and to render permanent the pictures thus delineated by the magic pencil of light. To accomplish this end, no tedious or troublesome process is required; unlike the creations of the painter's art, the picture is not the result of long and tiring manipulation. In a moment all our work is done, our desires are fully accomplished.

3. Photography is an art of but recent date. True it is that it has been asserted, we fear upon questionable authority, that the jugglers of India were for many ages in possession of a secret by which they were enabled, in a brief space, to copy the profile of any individual by light. Be this, however, as it may, it is certain that they have now lost all record of the art. Passing over this mere legend, we find that the effects of the sun's rays upon metallic compounds were really noticed by the alchemists, and in many old works the following experiment is given:—

"Dissolve chalk in aquafortis to the consistence of milk, and add to it a strong solution of silver; keep this liquor in a glass decanter well stopped; then cutting out from a paper the letters you would have appear, paste it on the decanter, and lay it in the sun's rays in such a manner that the rays may pass through the spaces cut out of the paper and fall on the surface of the liquor; the part of the glass through which the rays pass will be turned black, while that under the paper remains white; but particular care must be taken that the bottle be not moved during the operation."

This experiment, though so vaguely expressed, and so doubtful of success, that it was probably more frequently reprinted than repeated, is nevertheless the first certain record of the art we are about to describe. But

although the alchemists had by this experiment actually stumbled upon the threshold of the discovery of Photography, yet so intent were they upon their favourite search after the philosopher's stone, that everything which did not promise them a result now deemed so hopeless was thrown aside as of no value.

4. In 1556, it was observed that a combination of chlorine and silver, called, from its appearance, horn silver, was blackened by exposure to the sun's rays. This was the first step towards the discovery of the photogenic art, beyond which no further progress was made until, in the early part of the eighteenth century, Scheele, of Stralsund, discovered that this change of colour in the silver compound was produced by the blue rays, little or no effect being produced by red or yellow light. In the latter part of the last century, Mrs. Fulhame, in her "Essay on Combustion," published an experiment by which a change of colour was effected in the chloride of gold by the agency of light; and she added, that letters or words might be written in this way.

5. The first person who seems to have had any notion of Photography, as an art, was Mr. Wedgwood, who, in the year 1802, recorded an experiment in the Journal of the Royal Institution, to which his mind had been directed by observing that light blackened a solution of nitrate of silver, or, as it is more usually called, lunar caustic. The experiment of Mr. Wedgwood was as follows: — A piece of paper, or other convenient material, was placed on a frame and sponged over with a solution of nitrate of silver; it was then placed behind a painting on glass, and the light traversing the painting produced a kind of copy upon the prepared paper, those parts in which the rays were least intercepted being of the darkest hues. Here, however, terminated the experiment; for although both Mr. Wedgwood and Sir Humphry Davy experimented carefully, for the purpose of endeavouring to fix the

drawings thus obtained, yet the object could not be accomplished, and the whole ended in failure.

6. It cannot then be a matter of wonder, that, after the failure of such men as Davy and Wedgwood, the subject should have been dropped for some time. Indeed, the art slumbered until 1814, when Mr. Niepce, of Chalons on the Soane, appears to have directed his attention to the production of pictures by light. He pursued his experiments on the subject alone for ten years, when chance having made him acquainted with Daguerre, they agreed conjointly to pursue the subject. In 1827, Niepce presented a paper to the Royal Society of London, on his method of taking pictures by means of light, naming his discovery Heliography;* but as he kept his process a secret, it could not, agreeably to one of their laws, be printed by them. The memoir was accompanied by several designs on glass, on copper plated with silver, and on well planished tin plate. Daguerre had at the same time produced some specimens on paper saturated with chloride of silver; but the want of sensibility in the preparation had necessarily rendered them extremely confused.

7. On the 31st of January, 1839, Mr. Fox Talbot communicated to the Royal Society his photographic discoveries;† and six months afterwards, the French philosophers published to the world their process, termed Daguerreotype. Mr. Talbot's most recent discovery, the Calotype, was accidental. He was trying some experiments on the relative sensitiveness of several kinds of paper, by exposing them for very short periods in the camera; some papers which were taken from the instrument, exhibiting no impressions, were thrown aside as useless, and remained in a dark

* From Ηλιος the sun, and γραφω to depict, to draw.

† Published in the London and Edinburgh Philosophical Magazine, vol. xiv. p. 126.

room; after some time, they fell again under his eye, and, strange to say, by a process of natural magic, pictures of the objects to which the camera had been pointed were found on them.

8. Previously, however, to the secret discovered by Daguerre and Niepce having been published, it was offered to the French Government, which entered into arrangements with them, by which they undertook to make public their discovery, on the receipt of an annuity of 250*l*. to Daguerre, and 166*l*. to Niepce. In the former case, this annuity has been increased to 446*l*. From this time the progress of the photographic art has been rapid, and the improvements in it manifold, owing to the continued exertions of Herschel, Talbot, Hunt, and others.

Having thus briefly considered the history of this important and pleasing science, we will proceed in the next place, to consider the principle on which the art depends.

9. Light acts upon all bodies. To the existence of this subtle agent alone do we owe our sense of all the varied beauties which are around us.

> "Efflux divine!—Nature's resplendent robe!
> Without whose vesting beauty all were wrapt
> In unessential gloom."

Light is the garb of nature, clothing the garden and the meadow, glowing in the ruby and the emerald, sparkling in the diamond, and decking with varied tints the entire animal and vegetable creation.

10. But if its effects be thus visible throughout the organic world, equally apparent and equally wonderful are they upon inorganized matter. In some instances we may observe that the action of light will induce the combination of bodies, while in others it will effect their decomposition. Thus, chlorine and hydrogen will remain in a glass vessel without alteration, if kept in the dark; while, on the contrary, if

exposed to the rays of the sun, they enter into combination, and form hydrochloric acid. On the other hand, if colourless nitric acid be exposed to the sun's rays, it becomes yellow, then changes to red, and oxygen is liberated by the partial decomposition effected by the solar rays.

11. But of the inorganic substances none are more readily acted upon by light than the various combinations of silver. Of these, some are more and others less sensitive. If chloride of silver, which is a white precipitate formed by adding chloride of sodium (common salt) to solution of nitrate of silver, be exposed to diffused daylight, it speedily assumes a violet tint, and ultimately becomes nearly black. With iodide of silver, bromide of silver, ammonio-nitrate of silver, and other salts of this metal, the results will be much the same.

But the researches in this branch of science have made us acquainted with facts yet more extraordinary, which we will here briefly record. It has been observed that some bodies, which, under the influence of daylight, undergo certain chemical changes, have the power of restoring themselves to their original condition in the dark. This phenomenon is displayed most strikingly in the iodide of platinum, which readily receives a photographic image by darkening over the exposed surfaces, but speedily loses it by bleaching in the dark. The ioduret of Daguerre's plate, and some other iodides, exhibit the same peculiarity. We are hence led to the singular and striking fact *that bodies which have undergone a change of state under the influence of daylight have some latent power by which they can renovate themselves.* Possibly the hours of night are as necessary to inanimate nature as they are to men and animals. During the day, an excitement which we do not heed, unless in a state of disease, is maintained by the influence of light; and the hours of repose during which the equilibrium is restored are most essential to the continuance of health. Instead

of a few chemical compounds of gold and silver, which at first were alone supposed to be photographic, we now know that copper, platinum, lead, nickel, and, indeed, probably all the elements, are equally liable to change under solar influence. How great, then, must be the disturbance over the face of our planet during the period the sun is above the horizon! How varied must be the developments of electrical, chemical, and calorific phenomena, under this excitation! How beautiful that design by which, during external quiescence, matter is enabled to resume its former state, and during apparent rest busily to restore to the balance that which it has lost!

Another very remarkable effect of light is, that it appears to impart to bodies some power by which they more readily enter into chemical combination with others. We have already said that chlorine and hydrogen, if kept in the dark, will remain unaltered, but if the chlorine alone be previously exposed to sunshine, the chlorine thus solarized will unite with the hydrogen in the dark. Sulphate of iron will throw down gold or silver from their solutions slowly in the dark; but if either solution be first exposed to sunshine, and the mixture be then made in the dark, the precipitation takes place instantly. Here is again evidence of either an absorption of some material agent from the sunbeam, or of an alteration in the chemical constitution of the body.

12. Although it is utterly impossible, in a little work like this, to enter into a detail of the theories of light, still we deem it necessary to the clear apprehension of the subject, to allude briefly to the mode in which the chemical effects of light are accounted for on the undulatory theory. It is found by the prismatic spectrum, that each ray of white light is made up of seven different kinds of light, of different colours, namely,—red, orange, yellow, green, blue, indigo, violet. Now, in the theory which supposes light to consist in the

vibrations or undulations of a highly elastic medium, it is imagined that the waves of red light are longer than any of the others, and that the length decreases from the red to the violet, which is the shortest; but the violet wave, in order to make up for this difference, is quicker in its travel,—that is to say, it creates a greater number of undulations in a given time. Now, the undulatory theorists further suppose, that all chemical change depends upon the motion communicated to the particles of ethereal fluid by these undulations, and that the violet ray would, therefore, by its greater rapidity of motion, produce the greatest chemical change. And this is found to be the case. So late as the year 1801, Mr. Ritter, of Jena, discovered that the chemical effects of the spectrum resided at the violet end, and that the red ray had little or no chemical influence on the most sensitive preparations.

13. The knowledge of this fact has led Mr. Claudet to construct the windows of his photogenic apartment at the Adelaide Gallery of blue glass, thus excluding the rays which oppress vision without contributing to the photographic result.

14. We shall now proceed to describe in due order the various photographic processes. Before, however, doing this, it is necessary, above all things, to impress on the mind of the experimenter, the necessity which exists for extreme care in every stage of the manipulation; for it is but natural to suppose that an art, which involves the most delicate chemical changes, should require that more than ordinary caution should be taken in selecting the materials used for carring it into effect.

II. APPARATUS AND MATERIALS.

15. *Paper.*—The principal difficulty to be contended with in using paper, is the different power of imbibition which we often find possessed by the same sheet, owing

to trifling inequalities in its texture. This is, to a certain extent, to be overcome by a very careful examination of each sheet, by the light of a candle or lamp at night, or in the dark. By extending each sheet between the light and the eye, and slowly moving it up and down, and from left to right, the variations in its texture will be seen by the different quantities of light which pass through it in different parts; and it is always the safest course to reject every sheet in which inequalities exist. Paper sometimes contains minute portions of thread, black or brown specks, and other imperfections, all of which materially interfere with the process. Some paper has an artificial substance, given to it by sulphate of lime (plaster of Paris); this defect only exists, however, in the cheaper sorts of demy, and therefore can be easily avoided. In all cases such paper should be rejected, as no really sensitive material can be obtained with it. Paper-makers, as is well known, usually affix their name and the date of manufacture to one half of the sheet; this moiety should likewise be placed aside, as the letters most frequently come out with annoying distinctness. Well sized paper is by no means objectionable, indeed, is rather to be preferred, since the size tends to exalt the sensitive powers of the silver. Unsized paper has been recommended by some, but experience would rather teach its impropriety. The principal thing to be avoided, is the absorption of the sensitive solution into the pores; and it must be evident that this desideratum cannot be obtained by unsized paper. Taking all things into consideration, the paper known as *satin post* would appear to be preferable, although the precautions already recommended should be taken in its selection. As a general rule, the best paper for the purpose, is Whatman's satin post, sold by nearly all stationers. A very thin paper is frequently used where the transfer of the photograph is required; but by a process, elsewhere explained, this is not requisite.

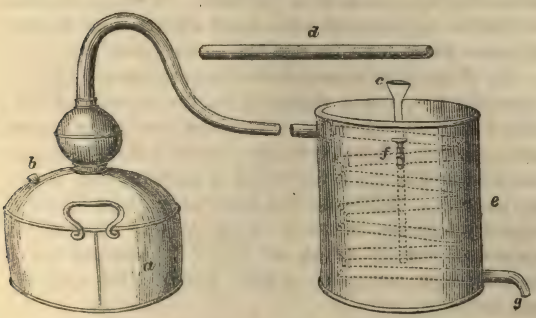
16. *Brushes.*—The necessary solutions are to be laid upon the paper with a brush. Some persons pass the paper over the surface of the solution, thus licking up, as it were, a portion of the fluid; but this method is apt to give an uneven surface unless great dexterity of manipulation be employed: it also rapidly spoils the solutions. At all events, the brush is the most ready and the most effectual means. It should be formed of camel or badger hair—should not have any metal in contact with it, and should be sufficiently broad and large to cover the paper in two or three sweeps; for if a small one be employed, it will be evident that many strokes must be given, which is very likely to leave corresponding marks. Many otherwise good pictures are spoiled by a neglect of this apparently trifling matter. It must further be remembered that each solution requires its distinct brush, which, after use, must be immediately washed in distilled water.

17. *Distilled Water.*—All the water used both for mixing the solutions, washing the papers, or cleansing the brushes, must be distilled; clean rain-water, however, answers the purpose tolerably well. Common water holds various substances in solution, which will infallibly ruin the whole operations. It must likewise be remembered, that distilled water should never be used but for one operation; thus, for example, we must not wash the sensitive calotype paper, hereafter to be described, in the same water as that in which the fixed paper is to be placed and *vice versa*. The best and surest method is to change the water after use.

Distilled water can be procured of most chemists; but in an economical point of view, this is not an advantageous way of obtaining it. The experimenter may easily distil it himself.

Fig. 1 represents a convenient and economical still for the purpose. The whole is made of tinned iron, and can be used on a common fire. *a* is the body holding one gallon of water, which is introduced at the open-

Fig. 1.



ing *b*, which is then stopped by a cork. The tube *d* connects the neck of the still with the worm tub or refrigeratory *e*, which is filled with cold water, a supply being kept up through the funnel *c*, the hot water is drawn off through the cock *f*; the different joints are rendered tight by lute, or, in the absence of it, some stiff paste spread on a piece of broad tape, and put round them, answers very well. The distilled water is condensed in the worm, and passing off at the pipe *g*, is collected and preserved for use in a glass bottle.

A glass retort connected with a Liebig's condenser forms a very convenient apparatus for distilling water, and may be heated either by an argand-lamp, gas-light, or small chauffer.

18. *Blotting Paper.*—In many instances, the prepared paper requires to be lightly dried with bibulous paper. The best description is the white sort, which may be obtained at most stationers. In each stage of the preparation distinct portions of bibulous paper must be used. If these be kept separate, and marked, they can be again employed for the same stage; but it would not do, for example, to dry

the finished picture in the same folds in which the sensitive paper had been pressed. A very convenient method is to have two or three quarto-size books of bibulous paper, one for each separate process.

19. *Nitrate of Silver.*—In the practice of the photographic art, much depends on the nitrate of silver. Care should be taken to procure the best; the crystallized salt is most suitable for the purpose, the variety sold in sticks, under the name of lunar caustic, not answering so well. While in the form of crystal it is not injured by being exposed to light, but the bottles containing the solutions of this salt should at all times be kept wrapped in dark paper, and excluded from daylight.

III. DIFFERENT METHODS OF PREPARING THE PAPER.

20. *Preparation of the Paper.*—Dip the paper to be prepared into a weak solution of common salt. The solution should not be saturated, but six or eight times diluted with water. When perfectly moistened, wipe it dry with a towel or press it between bibulous paper, by which operation the salt is uniformly dispersed throughout its substance. Then brush over it, on one side only, a solution of nitrate of silver. The strength of this solution must vary according to the colour and sensitiveness required. Mr. Talbot recommends about fifty grains of the salt to an ounce of distilled water. Mr. Golding Bird advises twenty grains only to the ounce. I have been accustomed to use a solution of the strength of eighty grains to an ounce, and I have found it to make an excellent and very sensitive paper. When dried in a dark room, the paper is fit for use. To render this paper still more sensitive, it must again be washed with salt and water, and afterwards with the same solution of nitrate of silver, drying it between times. This paper, if carefully made, is very useful for all ordinary photogenic purposes. For example, nothing can be

more perfect than the images it gives of leaves and flowers, especially with a summer's sun: the light, passing through the leaves, delineates every ramification of their fibres. In conducting this operation, however, it will be found that the results are sometimes more and sometimes less satisfactory, in consequence of small and accidental variations in the proportions employed. It happens sometimes that the chloride of silver formed on the surface of the paper is disposed to blacken of itself, without any exposure to light. This shows that the attempt to give it sensibility has been carried too far. The object is, to approach as nearly to this condition as possible without reaching it; so that the preparation may be in a state ready to yield to the slightest extraneous force, such as the feeblest effect of light.

21. *Cooper's Method.*—Soak the paper in a boiling-hot solution of chlorate of potash (the strength matters not) for a few minutes; then take it out, dry it, and wet it with a brush on one side only with a solution of nitrate of silver, sixty grains to an ounce of distilled water, or, if not required to be so sensitive, thirty grains to the ounce will do. This paper possesses a great advantage over any other, for the image can be fixed by mere washing. It is, however, very apt to become discoloured even in the making, or shortly afterwards, and is, besides, not so sensitive, nor does it become so dark as that made according to Mr. Talbot's method.

22. *Daguerre's Method.* — Immerse the paper in hydrochloric (or, as it is more commonly called, muriatic) ether, which has been kept sufficiently long to have become acid; the paper is then carefully and completely dried, as this is essential to its proper preparation. It is then dipped into a solution of nitrate of silver, and dried without artificial heat in a room from which every ray of light is carefully excluded. By this process it requires a very remark-

able facility in being blackened on a very slight exposure to light, even when the latter is by no means intense. The paper, however, rapidly loses its extreme sensitiveness to light, and finally becomes no more impressionable by the solar beams than common nitrate paper.

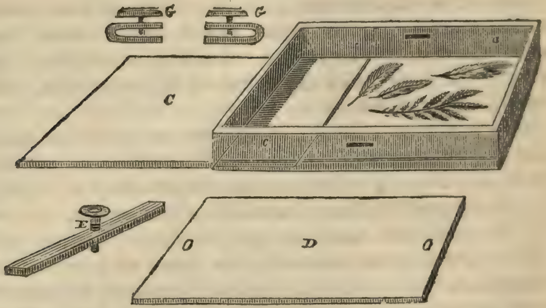
23. *Bromide Paper.*—Of all common photographic paper, the best, because the least troublesome in making, and the most satisfactory in result, is that which is termed bromide paper, and which is thus prepared:—Dissolve 100 grains of bromide of potassium in one ounce of distilled water, and soak the paper in this solution. Take off the superfluous moisture, and when nearly dry, brush it over on one side only with a solution of 100 grains of nitrate of silver to an ounce of distilled water. The paper should then be dried in a dark room, and, if required to be very sensitive, should a second time be brushed over with the nitrate of silver solution.

24. In preparing the papers mentioned above, there are two circumstances which require particular attention. In the first place, it is necessary to mark one side of the paper. It will be seen in every one of the methods of which mention has been made, that the nitrate of silver solution is applied to one side only. In order, therefore, to be able to know the sensitive side, it is necessary to place a mark on its extreme edge. This answers two purposes: in the first place, it serves to inform the experimentalist of the sensitive surface; and secondly, it will be a guide as to which portion of the paper has been handled during the application of the solution, as the impress of the finger will probably come out upon the photograph. The second caution is, that the application of the sensitive solution (nitrate of silver) and the subsequent drying of the paper, must be always conducted in a perfectly dark room, the light of a candle being alone used.

IV. PHOTOGENIC DRAWING AND ITS APPLICATION.

25. The simplest mode is to procure a flat board and a square of plate glass, larger in size than the object intended to be copied. On the board place the photogenic paper with the prepared side upwards, and upon it the object to be copied; over both lay the glass, and secure them so that they are in close connection by means of binding screws or clamps, similar to G, G, Fig. 2. Should the object to be copied be of unequal thickness, such as a leaf, grass, &c., it will be necessary to place on the board, first, a soft cushion, which may be made of a piece of fine flannel and cotton wool. By this means the object is brought into closer contact with the paper, which is of great consequence, and adds materially to the clearness of the copy. The paper is now exposed to diffused daylight, or, still better, to the direct rays of the sun, when that part of the paper not covered with the object will become tinged with a violet colour, and if the paper be well prepared, it will in a short time pass to a deep brown or bronze colour. It must then be removed, as no advantage will be obtained by keeping it longer exposed; on the contrary, the delicate parts yet uncoloured will become in some degree affected. The photogenic paper will now show a more or less white and distinct representation of the object. Fig. 2 represents a more convenient apparatus: it consists of a wooden frame similar to a picture-frame; a piece of plate glass is fixed in front; and it is provided with a sliding cover of wood, C, which is removed when the paper is ready to be exposed to the action of the light. The back, D, which is furnished with a cushion, as just described, is made to remove for the purpose of introducing the object to be copied, and upon it the prepared paper; the back is then replaced, and, by aid of the cross piece and screw, E, the whole is brought into close contact with the glass.

FIG. 2.



26. The objects best delineated on these photographic papers, are lace, feathers, dried plants, particularly the ferns, sea-weeds, and the light grasses, impressions of copper-plate and wood engravings, particularly if they have considerable contrast of light and shade—(these should be placed with the face downwards, having been previously prepared; § 30), paintings on glass, stained windows, etchings, &c.

27. *To fix the Drawings.*—Mr. Talbot recommends that the drawing should be dipped in salt and water, and in many instances this method will succeed, but at times it is equally unsuccessful. Iodide of potassium, or, as it is frequently called, hydriodate of potash, dissolved in water, and very much diluted (25 grains to 1 oz. of water), is a more useful preparation to wash the drawings with; it must be used very weak or it will not dissolve the unchanged muriate only, as is intended, but the blackened oxide also, and the drawing be thereby spoiled.

28. But the most certain material to be used is the hyposulphite of soda. 1 oz. of this salt should be dissolved in about a pint of distilled water. Having previously washed the photogenic drawing in a little

lukewarm water, which of itself removes a large portion of the muriate of silver which is to be got rid of, it should be dipped once or twice in the hyposulphite solution. By this operation the muriate which lies upon the lighter parts will become so altered in its nature as to be unchanged by light, while the rest remains dark as before.

29. It will be evident, from the nature of the process, that the lights and shadows of an object are reversed. That which is originally opaque will intercept the light, and consequently those parts of the photogenic paper will be least influenced by light, while any part of the object which is transparent, by admitting the light through it, will suffer the effect to be greater or less in exact proportion to its degrees of transparency. The object wholly intercepting the light will show a white impression; in selecting, for example, a butterfly for an object, the insect, being more or less transparent, leaves a proportionate gradation of light and shade, the most opaque parts showing the whitest colours. It may be said, therefore, that the representation is not natural. This is admitted, and in order to obtain a just delineation, we must place our first acquired photograph upon a second piece of photogenic paper. Before we do this, however, we must render our photographic picture transparent, otherwise the opacity of the paper itself will mar our efforts.

30. To accomplish this object, the back of the paper containing the negative or first acquired photograph should be covered with white or virgin wax. This may be done by scraping wax upon the paper, and then, after placing it between two other portions of paper, passing a heated iron over it. The picture, being thus rendered transparent, should now be applied to a second piece of photogenic paper, and exposed, in the manner before directed, either to diffused daylight or to the direct rays of the sun. The light will now penetrate the whiter parts, and the second photograph

be the reverse of the former, or a true picture of the original.

In lieu of wax, I have been accustomed to make use of boiled oil, a preparation obtained at any oil-shop. The back of the negative photograph should be smeared with the oil, and then placed between folds of bibulous paper. When dry, the photograph is highly transparent.

31. *Application.*—Mr. Talbot has recorded so many applications of the art of photography, that little can be added to the list. They may be summed up briefly as follows:—

The copying of paintings on glass by the light thrown through them on the prepared paper. Imitations of etchings, suggested by Mr. Havell, but since claimed by Mr. Talbot. These are done by painting a piece of glass with a thick coat of white oil paint; when dry, with the point of a needle, lines or scratches are to be made through the white lead ground, so as to lay the glass bare; then place the glass upon a piece of prepared paper, and of course every line will be represented beneath of a black colour, and thus an imitation etching will be produced. The delineation of microscopic objects, architecture, sculpture, landscapes, and external nature.

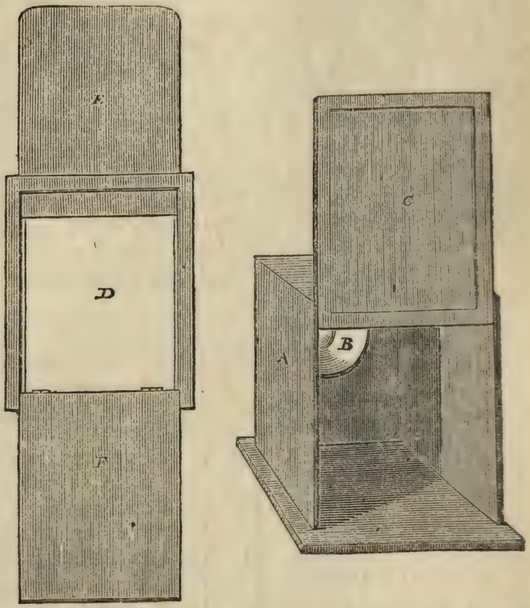
32. A novel application of this art has been recently suggested, which would doubtless prove useful in very many instances. By rendering the wood used for engraving sensitive to light, impressions of objects may be at once made thereon, without the aid of the artist's pencil. The preparation of the wood is simply as follows:—place its face or smooth side downwards, in a plate containing twenty grains of common salt dissolved in an ounce of water; here let it remain for five minutes, take it out and dry it; then place it again face downwards in another plate containing sixty grains of nitrate of silver to an ounce of water; here let it rest one minute, when taken out and dried in the

dark it will be fit for use, and will become, on exposure to light, of a fine brown colour. Should it be required more sensitive, it must be immersed in each solution a second time, for a few seconds only. It will now be very soon affected by a very diffused daylight. This process may be useful to carvers and wood-engravers; not only to those who cut the fine objects of artistical design, but still more to those who cut patterns and blocks for lace, muslin, calico-printing, paper-hangings, &c., as by this means the errors, expense, and time of the draughtsman may be wholly saved, and in a minute or two the most elaborate picture or design, or the most complicated machinery, be delineated with the utmost truth and clearness.

V. THE CAMERA.

33. *Camera.*—We shall now proceed to a description of the Photographic Camera, an instrument which we have hitherto scarcely named, as the various papers we have been describing are none of them sufficiently sensitive to be used in it, requiring a stronger light, as well as a very considerable time before an image could be impressed upon them. To Mr. Fox Talbot is due the credit of discovering a process, by which paper can be rendered so sensitive that it can be readily acted upon by the light in the camera; "and the fleeting shadows as they pass" both caught and retained. His process, which is patented under the name of Calotype, as well as that discovered about the same period by Daguerre, and called Daguerreotype, we shall presently describe. The camera is, without doubt, the most important instrument in the photogenic art; consequently, it has undergone many modifications. The photographic camera differs from the ordinary camera-obscura: in the latter a considerable portion of light is unavoidably lost. At first sight the former appears to be a very simple piece of apparatus. It consists essentially of a wooden box, A, Fig.

Fig. 3.



3, at one end of which is the arrangement of lenses B, and at the other the ground glass C, fitted into a wooden frame sliding into a groove. The camera being placed opposite any object, it is delineated on the semi-transparent glass C. The proper focus is obtained, either by an adjustment in the mounting of the lenses or in the wood work. D represents the frame for holding the prepared paper, or silver plate; it is shown open. The dark slide E being down, the plate or paper is placed in the frame, and the flap F closed; this, of course, being done in the dark. The object to be taken being clearly portrayed on the ground-glass, care must be observed that the camera

is not moved; and for this purpose it should be fixed to a firm table, or to a tripod stand (very convenient ones may now be obtained). The cap or slide is now fixed over the front of the lens, the ground glass removed, and in its stead the frame containing the plate or paper is placed. The slide E being now raised, the cap is removed from the lens when the light acts upon the plate or paper, which having remained the proper time, the cap is replaced on the lens, the slide E put down, when the frame D can be removed entirely from the camera. This is the photogenic camera in its simplest form. As the art has advanced, various alterations and improvements have been made.

Fig. 4.

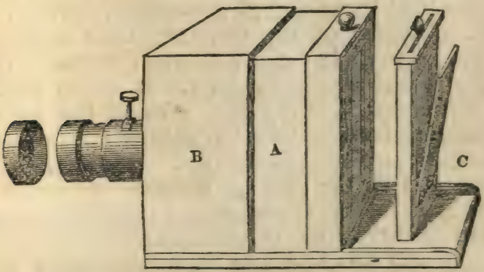


Fig. 4 represents the modern French form of camera, half the body A sliding into the other half B. This has the advantage of rendering the instrument more portable, and allowing a greater range; so that lenses, differing considerably in their focal length, can be used if necessary. C shows the frame, with its dark slide for holding the plate or paper.

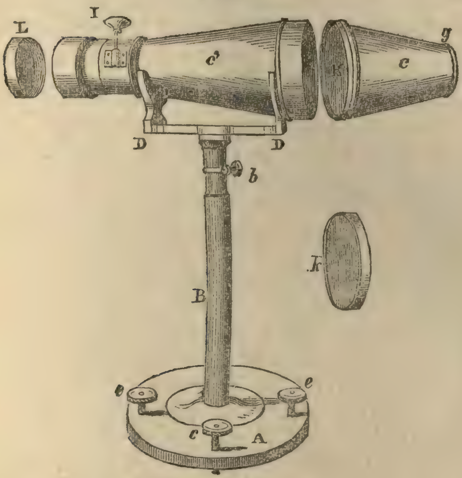
Messrs. Knight and Sons, the publishers of this little treatise, have taken considerable pains in their endeavours to construct an instrument that should be as complete in its various parts, and as portable in

itself as possible. The result of their ingenuity is well worthy the attention of all travellers and tourists who have any idea of practising this new and useful art during their rambles. Messrs. Knights' camera somewhat resembles the French instrument, Fig. 4; but the top, bottom, and sides are equal. This allows of the plates being placed either in an horizontal or vertical position, without the inconvenience of turning the camera on its side, which is the case in the French form. The plate-holder is made double, the plates themselves being fixed in an inner frame, made extremely light though strong, so that a considerable number, each with its prepared plate, can be packed within the body of the camera. They can also be placed when required in the outer frame, similar to C, Fig. 4, and removed from it without any risk of extraneous light impinging on the sensitive surface.

Fig. 5 represents the German, or Voigtlander's Camera; it is made entirely of brass, so that variation of climate has no effect upon it. It is very portable, and when packed in its box, with all the necessary apparatus and materials for practising the Daguerreotype art, occupies but little space. It is not, however, well adapted for the calotype process.

The brass foot A, is placed on a table, or other firm support, and the pillar B screwed into it; the body of the camera C C is laid into the double forked bearing D D. The instrument is now properly adjusted by means of the set screws *e e e* in the brass foot, or it may be raised, lowered, or moved from one side to the other, by the telescope-stand, and when correct, fixed by the screw *b*. The landscape or portrait to be delineated is viewed either through the small lens *g*, or with the naked eye on the ground glass plate H, the focus being adjusted by the screw I. The optical part of the instrument consists of the small set of achromatic lenses presently to be described. When the view or portrait to be taken is delineated on the ground glass to the entire satisfaction of the operator, the

Fig. 5.



brass cap L is placed over the lens, and the entire body is removed away into the dark, taking care not to disturb the position of the stand. The body is now detached at the part H, and the prepared paper or plate inclosed in the brass frame K introduced in its place; the whole is again placed on the pedestal, the brass cap L is removed by which the paper or plate is exposed to the full influence of the light, after which the cap is again replaced.

Mr. Claudet, the well-known and successful operator in this interesting art at the Adelaide Gallery, and the first person to purchase a license under the original Daguerreotype patent, patented himself, amongst other matters connected with it, a camera. Its chief merit is, that different lenses are readily adapted to it, and it is provided with a variety of frames for various-sized plates.

Mr. Beard, the gentleman who subsequently purchased the remainder of the Daguerreotype patent, patented a camera in which lenses were altogether laid aside, and their place supplied by a concave mirror. The advantage derived from this construction is the greater rapidity with which it acts, but there are many inconveniences attached to it; it is only applicable to the small-sized plates, neither is it so portable or easy of management as the others. It is very little used by amateurs, but principally confined to the photographic establishments licensed by Mr. Beard.

34. *The Lenses.*—These should be achromatic, more especially if we are operating on plates and not paper (Daguerreotype). The diameter and focal length must depend in a great measure on the distance of the object, and also on the superficies of the plate or paper to be covered. For portraits, one of $1\frac{1}{2}$ in. diameter, and from $4\frac{1}{2}$ in. to $5\frac{1}{2}$ in. focus may be used; but for distant views, one from 2 in. to 3 in. diameter, and from 8 in. to 12 in. focal length will be found to answer better. For single lenses, the aperture in front should be placed at a distance from it, corresponding to the diameter, and of a size not more than one-third of the same. A variety of moveable apertures, or diaphragms, are often useful, as by them the intensity of the light may be modified, and more or less distinctness and clearness of delineation obtained. Though the single achromatic lens answers very well for copying engravings, taking views from nature, buildings, &c., for the portrait, figures, and groups from life, it is almost entirely superseded by the double achromatic, which acts very much more quickly; and these have been brought to the greatest state of perfection by M. Voigtlander, of Vienna, under the direction of Dr. Petzval, Professor of Mathematics in that university. His small-size arrangement consists of two separate achromatic lenses; the first, or external one,

has a free aperture of $1\frac{1}{2}$ in.; the second, $1\frac{5}{8}$ in.; and both have the same focus, viz. $5\frac{3}{4}$ in.

The larger size differs from the smaller; the inner lens is an achromatic $3\frac{1}{4}$ in. diameter, its focal length 30 in.; the second, or outer lens, is a meniscus, having a focal length of 18 in. The combined length of the two being $10\frac{3}{4}$ in. For very distant views the aperture in front is contracted to $\frac{7}{8}$ of an inch. By these means the light is reflected with considerable intensity, and the clearness and correctness of the delineation, are truly surprising. The success of the arrangement is evident from the general adoption of these cameras in taking of portraits, where the greatest perfection is required.

Mr. Cundell, in a paper published in the Philosophical Magazine,* "On the Practice of the Calotype Process," and containing much useful information, "recommends a lens of the meniscus form, of about 12 in. focus. This, when mounted, should have an aperture of $2\frac{4}{10}$ in. A diaphragm is placed at $1\frac{1}{4}$ in. in advance of the lens, and its opening ought not to exceed $1\frac{2}{10}$ in. By using one of smaller opening a much finer image will be obtained, but at the sacrifice of light. At short distances, however, on account of the increasing divergence of the rays, only a small opening, admitting the mere centres of the pencils, can be used with advantage. With this arrangement the size of the paper may be eight inches by six.

"It must be observed of this camera, and of all others which are not achromatic, that there is a peculiar adjustment required of the focus, the not attending to which has been the cause of much failure and disappointment. The instrument must be adjusted to what has been appropriately called the chemical focus, which differs materially from the optical or visible focus, the former being about one thirty-sixth

* Phil. Mag., No. 160, vol. xxiv. May, 1844.

part shorter than the latter for parallel rays, and for diverging rays still more according to the degree of divergence."

VI. CALOTYPE.

35. In January 1839, Mr. Henry Fox Talbot's researches in the photogenic art were first made known in a paper read before the Royal Society, and in the following month this paper was succeeded by another, when the method of preparing the paper was given, and the process by which the design was fixed particularly described. Subsequently, further improvements were made, and in the same year, Mr. Talbot patented his process under the name of "Calotype."

36. Before entering upon a description of it, it would be as well to enumerate the apparatus and materials required by the experimentalist previously to his proceeding to practice it. They are two or three shallow dishes, A A Fig. 12, for holding distilled water, iodide, potassium, &c., the same water never being used for two different operations, white bibulous paper, photogenic camera.

Pressure frame, Fig. 2.

A screen of yellow glass.

In preparing the calotype paper, it is necessary to be extremely careful, not only to prevent the daylight impinging on it, but also to exclude, if possible, the strong glare of the candle or lamp. This may be effected by using a shade of yellow glass or yellow gauze, which must be placed around the candle or lamp. Light passing through such a medium will scarcely affect the sensitive compounds, the yellow glass intercepting the chemical rays.

Camel or badger hair brushes: — a separate one being kept for each stage of the process, and immediately after being used it should be washed in distilled water. That used for the gallo-nitrate is soon de-

stroyed, owing to the rapid decomposition of that preparation.

A graduated measure.

A hot water apparatus for drying the paper will be found extremely useful.

Three or four flat boards, to which the paper may be fixed with drawing pins. The paper must be of the very best, as described (§ 15).

37. *Preparation of the Iodized Paper.*—Dissolve 100 grains of crystallized nitrate of silver in six ounces of distilled water, and having fixed the paper to one of the boards, brush it over with a soft brush on one side only with this solution, a mark being placed on that side whereby it may be known. When nearly dry, dip it into a solution of iodide of potassium, containing 500 grains of that salt dissolved in a pint of water. When perfectly saturated with this solution, it should be washed in distilled water, drained, and allowed to dry. This is the first part of the process, and the paper so prepared is called *iodized paper*. It should be kept in a portfolio or drawer until required: with this care it may be preserved for any length of time without spoiling or undergoing any change.

Mr. Cundell, in his paper before referred to (§ 34), states, that he finds a stronger solution of nitrate of silver preferable, and that he employs thirty grains to the ounce of distilled water: he also adds fifty grains of common salt to the iodide of potassium, which he applies to the marked side of the paper only. This is the first process.

38. *Preparation of the Paper for the Camera.*—The second process consists in applying to the above a solution which has been named by Mr. Talbot the "Gallo-Nitrate of Silver;" it is prepared in the following manner: dissolve 100 grains of crystallized nitrate of silver in two ounces of distilled water, to which is added one-sixth of its volume (that is to say $2\frac{2}{3}$ drachms) of strong acetic acid. This solution should

be kept in a bottle carefully excluded from the light. Now, make a saturated solution of gallic acid in cold distilled water: the quantity dissolved is very small. When it is required to take a picture, the two liquids above described should be mixed together in equal quantities; but as it speedily undergoes decomposition, and will not keep good for many minutes, only just sufficient for the time should be prepared, and that used without delay. It is also well not to make much of the gallic acid solution, as it will not keep for more than a few days without spoiling. A sheet of the iodized paper should be washed over with a soft brush with this mixed solution, care being taken that it be applied to the marked side. This operation must be performed by candle-light. Let the paper rest half a minute, then dip it into one of the dishes of water, Fig. 12, passing it beneath the surface several times: it is now allowed to drain, and dried, by placing its marked side upwards on the drying apparatus. It is better not to touch the surface with bibulous paper: it is now highly sensitive, and is ready to receive the impression. In practice, it is found better and more economical not to mix the nitrate of silver and gallic acid, but only to brush the paper with the solution of the nitrate.

Mr. Talbot has recently proposed some modifications in his method of preparing the calotype paper. The paper is first iodized in the usual way; it is then washed over with a saturated solution of gallic acid in distilled water and dried. Thus prepared, he calls it the io-gallic paper: it will remain good a considerable time, if kept in a press or portfolio. When required for use, it is washed with a solution of nitrate of silver (fifty grains to the ounce of distilled water), and it is then fit for the camera.

39. *Exposure in the Camera.*—The calotype paper thus prepared possesses a very high degree of sensibility when exposed to light, and we are thus provided

with a medium by which, with the aid of the photogenic camera, we may effectually copy views from nature, figures, buildings, and even take portraits from the shadows thrown on the paper by the living face. The paper may be used somewhat damp. The best plan of fixing it in the camera is to place it between a piece of plate glass and some other material with a flat surface, as a piece of smooth slate or an iron plate, which latter, if made warm, renders the paper more sensitive, and consequently the picture is obtained more rapidly.

Time of Exposure.—With regard to the time which should be allowed for the paper to remain in the camera, no direct rules can be laid down; this will depend altogether on the nature of the object to be copied, and the light which prevails. All that can be said is, that the time necessary for forming a good picture varies from thirty seconds to five minutes, and it will naturally be the first object of the operator to gain by experience this important knowledge.

40. *Bringing out the Picture.*—The paper when taken from the camera, which should be done so as to exclude every ray of light, bears no appearance of the picture which in reality is formed. The impression is latent and invisible, and its existence would not be suspected by any one who was not acquainted with it by previous experiments. The method of bringing out the impression is extremely simple. It consists in washing the paper with the *gallo-nitrate of silver*, prepared in the way already described, and then warming it gently, being careful at the same time not to let any portion become perfectly dry. In a few seconds the part of the paper upon which the light has acted will begin to darken, and finally grow entirely black, while the other part of the paper retains its original colour. Even a weak impression may be brought out by again washing the paper with the gallo-nitrate, and once more gently warming it. When the paper is

quite blank, as is generally the case, it is a highly curious and beautiful phenomenon to witness the spontaneous commencement of the picture, first tracing out the stronger outlines, and then gradually filling up all the numerous and complicated details. The artist should watch the picture as it developes itself, and when in his judgment it has attained the greatest degree of strength and clearness, he should stop further proceedings by washing it with the fixing liquid. Here again the mixed solution need not be used, but the picture simply brushed over with the solution of gallic acid.

41. *The Fixing Process.*—"In order to fix the picture thus obtained, first dip it into water, then partly dry it with blotting-paper, and wash it with a solution of bromide of potassium containing 100 grains of that salt dissolved in eight or ten ounces of distilled water. The picture is again washed with distilled water, and then finally dried. Instead of bromide of potassium, a solution of hyposulphite of soda, as directed (§ 28), may be used with equal advantage.

42. It was at one time supposed that terrestrial or artificial light possessed no chemical rays, but this is incorrect; Mr. Brande discovered that although the concentrated light of the moon, or the light even of olefiant gas, however intense, had no effect on chloride of silver, or on a mixture of chlorine and hydrogen, yet the light emitted by electrized charcoal blackens the salt. At the Royal Polytechnic Institution pictures have been taken by means of sensitive paper, acted upon by the Drummond light. But it must of course be distinctly understood that they are far inferior to those taken by the light of the sun or diffused daylight.

43. The calotype picture, like the photographic one which we first described, is negative, that is to say, it has its lights and shades reversed, giving the whole an appearance not conformable to nature. But it is

easy from this picture to obtain another which shall be conformable to nature, viz., in which the lights shall be represented by lights, and the shades by shades. It is only necessary for this purpose to take a sheet of photogenic paper (the bromide paper is the best), and place it in contact with a calotype picture, previously rendered transparent in the manner before recommended, § 30. Fix it in the frame Fig. 2, expose it in the sunshine for a short time, and an image or copy will be formed upon the photogenic paper. The calotype paper itself may be used to take the second picture, but this Mr. Talbot does not recommend, for although it takes a much longer time to take a copy on the photogenic paper, yet the tints of such copy are generally more harmonious and agreeable. After a calotype picture has furnished a good many copies it sometimes grows faint, and the subsequent copies are inferior. This may be prevented by means of a process which revives the strength of the calotype pictures. In order to do this, it is only necessary to wash them by candle-light with gallo-nitrate of silver, and then warm them. This causes all the shades of the picture to darken considerably, while the white parts are unaffected. After this the picture is of course to be fixed a second time. It will then yield a second series of copies, and a great number of them may frequently be made."

44. The calotype pictures when prepared as we have stated possess a yellowish tint, which impedes the process of taking copies from them. In order to remedy this defect, Mr. Talbot has devised the following method. The calotype picture is plunged into a solution consisting of hyposulphite of soda dissolved in about ten times its weight of water, and heated nearly to the boiling point. The picture should remain in about ten minutes; it must then be removed, washed, and dried. By this process the picture is rendered more transparent, and its lights become

whiter. It is also rendered exceedingly permanent. After this process the picture may be waxed, as described § 30, and thus its transparency is increased. This process is applicable to all photographic papers prepared with solutions of silver.

45. Having thus fully, and it is hoped clearly, considered the process, it may be necessary, before entirely dismissing the calotype from notice, to add one or two remarks from the observations and labours of some who have experimented in this art. Dr. Ryan, in his lectures on this subject at the Polytechnic Institution, has observed, that in the iodizing process the sensitiveness of the paper is materially injured by keeping it *too long* in the solution of iodide of potassium, owing to the newly formed iodide of silver being so exceedingly soluble in excess of iodide of potassium, as in a few minutes to be completely removed. The paper should merely be dipped in the solution and instantly removed.

There is another point, too, in the preparation of the iodized paper in which Mr. Mitchell, Dr. Ryan's assistant, suggests a slight deviation from Mr. Talbot's plan. In the first instance, he recommends the paper to be brushed over with the solution of the iodide of potassium, instead of the nitrate of silver, transposing, in fact, the application of the first two solutions. The paper, having been brushed over with the iodide of potassium in solution, is washed in distilled water and dried. It is then brushed over with nitrate of silver, and after drying is dipped for a moment in a fresh solution of iodide of potassium of only one-fourth the strength of the first, that is to say, consisting of 125 grains of the salt dissolved in one pint of water. After this it is again washed and dried. The advantage derived from this method is a more sensitive paper, and a more even distribution of the compounds over the surface.

The following deviation from Mr. Talbot's method

has been suggested and stated to answer equally well.

46. Brush the paper over with a solution of nitrate of silver, containing 100 grains of that salt to 1 oz. of distilled water. When nearly but not quite dry, dip it into a solution of iodide of potassium of the strength of twenty-five grains of the salt to one ounce of distilled water, drain it, wash it in distilled water, and again drain it. Now brush it over with aceto-nitrate of silver made by dissolving fifty grains of nitrate of silver in one ounce of distilled water, to which is added one-sixth of its volume of strong acetic acid. Dry it with bibulous paper, and it is now ready for receiving the image. When the impression has been received, which will require from one to five minutes according to the state of the weather, it must be washed with a saturated solution of gallic acid to which a few drops of the aceto-nitrate of silver, made as above, have been added. The image will thus be gradually brought out, and may be fixed with hyposulphite of soda. To obtain the positive picture, paper must be used brushed over with an ammonio-nitrate of silver, made thus:—forty grains of nitrate of silver is to be dissolved in one ounce of distilled water, and liquid ammonia cautiously added till it re-dissolves the precipitate.

47. A pleasing effect may be given to calotype, or indeed to all photographic pictures by waxing them at the back, as described § 30, and mounting them on white paper, or if coloured papers be used, various beautiful tones of colour are produced.

VII. POSITIVE CALOTYPE.

48. At the last meeting of the British Association, at York, Professor Grove described a process by which positive calotype pictures could be directly obtained, and thus the necessity of transfer by which the imperfections of the paper are shown, and which is more-

over a troublesome and tedious process, is avoided. As light favours most chemical actions, Mr. Grove was led to believe that a paper darkened by the sun (which darkening is supposed to result from the precipitation of silver) might be bleached by using a solvent which would not attack the silver in the dark, but would do so in the light. The plan found to be most successful is as follows:—ordinary calotype paper is darkened till it assumes a deep brown colour, almost amounting to black; it is then redipped into the ordinary solution of iodide of potassium, and dried. When required for use, it is drawn over dilute nitric acid, 1 part acid to $2\frac{1}{2}$ parts water. In this state, those parts exposed to the light are rapidly bleached, while the parts not exposed remain unchanged. It is fixed by washing in water, and subsequently in hyposulphite of soda, or bromide of potassium.

49. Mr. Grove likewise described on the same occasion another process which promises, when carried out, to be of great utility. It is the conversion of a negative calotype into a positive one, and was thus stated: —let an ordinary calotype image or portrait be taken in the camera, and developed by gallic acid; then drawn over iodide of potassium and dilute nitric acid and exposed to full sunshine; while bleaching the dark parts, the light is redarkening the newly precipitated iodide in the lighter portions and thus the negative picture is converted into a positive one.

50. The Calotype has already been applied in the arts, and Mr. Talbot has patented a process for printing, through its agency. His method is as follows:—some pages of letter-press are taken printed on one side only; they are waxed (§ 31.) to render them more transparent, and the letters are cut out and sorted. To compose a new page, lines are ruled on a sheet of white paper, and the words are formed by fixing the separate letters in their proper order. The page being ready, a negative photograph is produced from it, from

which the requisite number of positive photogenic copies may of course be obtained.

The second method, which requires the use of the camera, consists in employing large letters painted on rectangular pieces of wood, coloured white. These are arranged in lines on a tablet or board, by slipping them into grooves which keep them steady and upright, thus forming a page on an enlarged scale. It is now placed before a camera, and a reduced image of it of the required size is thrown upon the sensitive paper. The adjustments must be kept invariable, so that the consecutive pages may not vary from one another in the size of the type.

VIII. CHRYSOTYPE.

51. A modification of Mr. Talbot's process, to which the name of Chrysotype* was given by its discoverer, Sir John Herschel, was communicated in June 1843 to the Royal Society, by that distinguished philosopher. This modification would appear to unite the simplicity of photography with all the clearness and distinctness of calotype. This preparation is as follows:—the paper is to be washed in a solution of ammonio-citrate of iron; it must then be dried, and subsequently brushed over with a solution of the ferro-sesquicyanuret of potassium. This paper, when dried in a perfectly dark room, is ready for use in the same manner as if otherwise prepared, the image being subsequently brought out by any neutral solution of gold. Such was the first declaration of his discovery, but he has subsequently found that a neutral solution of silver is equally useful in bringing out the picture. Sir John Herschel observes, that photographic portraits taken on this paper are distinguished by a clearness of outline foreign to all other methods.

* From χρυσος gold, and τυπος a picture.

IX. CYANOTYPE,

52. So called from the circumstance of cyanogen in its combinations with iron performing a leading part in the process, it is likewise a discovery of Sir John Herschel. It has also been termed FERROTYPE. The process is a simple one, and the resulting pictures are blue. Brush the paper over with a solution of the ammonio-citrate of iron. This solution should be sufficiently strong to resemble sherry-wine in colour. Expose the paper in the usual way, and pass over it very sparingly and evenly a wash of the common yellow ferro-cyanate of potass. As soon as the liquid is applied, the negative picture vanishes, and is replaced by a positive one, of a violet blue colour on a greenish yellow ground, which at a certain time possesses a high degree of sharpness, and singular beauty of tint.

A curious process was discovered by Sir John Herschel, and communicated by him to the British Association during the past year, by which dormant pictures are produced capable of development by the breath, or by keeping in a moist atmosphere. It is as follows: If nitrate of silver, specific gravity 1·200, be added to ferro-tartaric acid, specific gravity 1·023, a precipitate falls, which is in a great measure redissolved by a gentle heat, leaving a black sediment, which, being cleared by subsidence, a liquid of a pale yellow colour is obtained, in which the further addition of the nitrate causes no turbidness. When the total quantity of the nitrated solution added amounts to about half the bulk of the ferro-tartaric acid, it is enough. The liquid so prepared does not alter if kept in the dark. Spread on paper, and exposed *wet* to the sunshine (partly shaded) for a few seconds, no impression seems to be made, but by degrees, although withdrawn from the action of the light, it developes itself spontaneously,

and at length becomes very intense. But if the paper be thoroughly dried in the dark (in which state it is of a very pale greenish yellow colour), it possesses the singular property of receiving a dormant or invisible picture, to produce which from thirty seconds' to a minute's exposure in the sunshine is requisite. It should not be exposed too long, as not only is the ultimate effect less striking, but a picture begins to be *visibly* produced, which darkens spontaneously after it is withdrawn. But if the exposure be discontinued before this effect comes on, an invisible impression is the result, to develope which all that is necessary is to breathe upon it, when it immediately appears, and very speedily acquires an extraordinary intensity and sharpness, as if by magic. Instead of the breath, it may be subject to the regulated action of aqueous vapour, by laying it in a blotting paper book, of which some of the outer leaves on both sides have been damped, or by holding it over warm water.

X. ENERGIATYPE.

53. Under this title a new process has been lately brought forward by Mr. Hunt. This consists in the application of a solution of succinic acid to paper, which is subsequently washed over with nitrate of silver. The image is then to be taken either in the camera or otherwise as required, and is brought out by the application of the sulphate of iron in solution. Although this process has not come into general use, its exact description may prove interesting to the reader, and we therefore subjoin it. The solution with which the paper is first washed is to be prepared as follows:—succinic acid, two drachms; common salt, five grains; mucilage of gum arabic, half a fluid drachm; distilled water, one fluid drachm and a half. When the paper is nearly dry, it is to be brushed over with a solution of nitrate of silver, containing a drachm of the salt, to an

ounce of distilled water. It is now ready for exposure in the camera. To bring out the dormant picture it is necessary to wash it with a mixture of a drachm of concentrated solution of the green sulphate of iron and two drachms and a half of mucilage of gum arabic.

Subsequently, however, it has been found that the sulphate of iron produces upon all the salts of silver effects quite as beautiful as in the succinate. On the iodide, bromide, acetate, and benzoate, the effects are far more pleasing and striking. When pictures are produced, or the dormant camera image brought out, by the agency of sulphate of iron, it is remarkable how rapidly the effect takes place. Engravings can be thus copied almost instantaneously, and camera views obtained in one or two minutes on almost any preparation of silver. The common sulphate of copper solution has, according to Mr. Hunt, the same property.

XI. CHROMATYPE.

54. Many efforts have been made to render chromatic acid an active agent in the production of photographs. M. Ponton used a paper saturated with bichromate of potash, and this was one of the earliest photogenic processes. M. Becquerel improved upon this process by sizing the paper with starch previous to the application of the bichromate solution, which enabled him to convert the negative picture into a positive one, by the use of a solution of iodine, which combined with that portion of the starch on which the light had not acted. But by neither of these processes could clear or distinct pictures be formed. Mr. Hunt has, however, discovered a process, which he has termed chromatype, by which positive pictures may very easily be produced. The paper to be prepared is washed over with a solution of sulphate of copper, and partially dried; it is then washed with a solution of bichromate of potash, and dried at a little distance from the fire. Papers thus

prepared may be kept any length of time, and are always ready for use. They are not sufficiently sensitive for use in the camera, but they are available for every other purpose. An engraving, botanical specimens, or the like, being placed upon the paper in a proper photographic copying frame (§ 25), it is exposed to sunshine for a time, varying with the intensity of light from five to fifteen or twenty minutes. The result is generally a negative picture. It is now to be washed over with a solution of nitrate of silver, which immediately produces a very beautiful deep orange picture upon a light dim coloured, or sometimes perfectly white ground. This picture must be quickly fixed, by being washed in pure water, and dried. With regard to the strength of the solutions, it is a curious fact, that, if saturated solutions be employed, a negative picture is first produced, but if the solutions be diluted with three or four times their bulk of water, the first action of the sun's rays darkens the paper, and then a very rapid bleaching effect follows, giving an exceedingly faint positive picture, which is brought out with great delicacy by the silver solution. It is necessary that pure water should be used for the fixing, as the presence of any muriate damages the picture, and here arises another pleasing variation of the chromatype. If the positive picture be placed in a very weak solution of common salt, the images slowly fade out, leaving a faint negative outline. If it now be removed from the saline solution dried and again exposed to sunshine, a positive picture of a lilac colour will be produced by a few minutes exposure. Several other of the chromates may be used in this process, but none is so successful as the chromate of copper above described.

XII. ANTHOTYPE.*

55. The expressed juice, alcoholic, or watery infu-

* From ανθος, a flower, and τυπος, a picture.

sion of flowers or vegetable substances, may be made the media of photogenic action, and the discovery of these interesting facts are, as in the former case, due to Sir John Herschel. The papaver hybridum, the double ten-week stock, the rose, guiacum, and many other plants, have given results which, although in a practical point of view almost useless, tend nevertheless to the explanation of facts which were heretofore somewhat obscure. Thus, the flowers which, imbued with the principle of vitality, whatever that may be, resist the influence of all exterior agents, bud, bloom and flourish in beauty and fragrance, become subject, when the vital energy is exhausted, to these very influences, especially to that of light; the colour vanishes or is changed; in fact a photogenic process has taken place.

It has long been known, although the reason was not understood, that plants excluded from light have not their natural colour, odour, nor flavour; they make little or no charcoal in the woody part, the leaves are not green, and if they do flower and bear fruit, which is rarely the case, the flowers are pale and scentless, and the fruit insipid. This has been proved by many experiments, of which the bleaching of celery and endive by earthing up, and that of a cabbage by the natural process of hearting, are familiar examples. A geranium, placed in a dark room, becomes first pale, then spotted, and ultimately white; and if brought to the light, it again acquires its colour. The knowledge of this fact, and the discoveries consequent thereon, have shown us the important influence exerted by the sun's rays on the vegetable world. Seed is placed in the earth; it is buried in darkness; under the influence of terrestrial heat and moisture it germinates, and a plant springs into daylight. It has been found that the influence of the most luminous rays, the yellow rays, even on the surface, is sufficient to prevent germination; and on the contrary, that the

blue rays forward very remarkably this process. Plants in all conditions of their growth, absorb by their leaves and bark atmospheric air, which is invariably contaminated with carbonic acid, produced during the processes of respiration and digestion by animals, and poured out in great abundance by all burning bodies. During the sunshine this carbonic acid is decomposed by the plant; one of its constituents, oxygen, is given off again to the air, while the carbon is retained by the plant, and contributes to the formation of the woody structure.

XIII. AMPHITYPE.*

56. The last process we have to describe in this portion of the work, is one recently made public by Sir John Herschel, and to which he has given the above name from the fact that both negative and positive photographs can be produced by one process. The positive pictures obtained by the process have a perfect resemblance to impressions of engravings with common printer's ink. The process, although not yet fully carried out, promises to be of vast utility, for which reason we deem it better to subjoin it in the words of its discoverer.†

"Paper proper for producing an amphitype picture may be prepared either with the ferro-tartrate or the ferro-citrate of the protoxide or the peroxide of mercury, or of the protoxide of lead, by using creams of these salts, or by successive applications of the nitrates of the respective oxides, singly or in mixture, to the paper, alternating with solutions of the ammonio-tartrate or the ammonio-citrate of iron, the latter solutions being last applied, and in more or less excess. I purposely avoid stating proportions, as I have not yet been able to fix upon any which certainly succeed.

* From αμφι, both, and τυπος, a picture.

† Read before the British Association, Sept. 31, 1844.

Paper so prepared and dried takes a negative picture, in a time varying from half an hour to five or six hours, according to the intensity of the light; and the impression produced varies in apparent force from a faint and hardly perceptible picture, to one of the highest conceivable fullness and richness both of tint and detail, the colour in this case being of a superb velvety brown. This extreme richness of effect is not produced except lead be present, either in the ingredients used, or *in the paper itself.* It is not, as I originally supposed, due to the presence of free tartaric acid. The pictures in this state are not permanent. They fade in the dark, though with very different degrees of rapidity, some (especially if free tartaric or citric acid be present) in a few days, while others remain for weeks unimpaired, and require whole years for their total obliteration. But though entirely faded out in appearance, the picture is only rendered dormant, and may be restored, changing its character from negative to positive, and its colour from brown to black (in the shadows) by the following process :—A bath being prepared by pouring a small quantity of solution of pernitrate of mercury into a large quantity of water, and letting the sub-nitrated precipitates subside, the picture must be immersed in it (carefully and repeatedly clearing off all air bubbles), and allowed to remain till the picture (if anywhere visible) is entirely destroyed ; or if faded, till it is judged sufficient from previous experience; a term which is often marked by the appearance of a feeble positive picture, of a bright yellow hue, on the pale yellow ground of the paper. A long time (several weeks) is often required for this, but heat accelerates the action, and it is often complete in a few hours. In this state the picture is to be very thoroughly rinsed and soaked in pure warm water, and then dried. It is then to be well ironed with a smooth iron, heated so as barely not to injure the paper, placing it, for better security against scorching,

between smooth clean papers. If then the process have been successful, a perfectly black positive picture is at once developed. At first it most commonly happens that the whole picture is sooty or dingy to such a degree that it is condemned as spoiled, but on keeping it between the leaves of a book, especially in a moist atmosphere, by extremely slow degrees this dinginess disappears, and the picture disengages itself with continually increasing sharpness and clearness, and acquires the exact effect of a copper-plate engraving on a paper more or less tinted with a pale yellow. I ought to observe, that the best and most uniform specimens which I have procured have been on paper previously washed with certain preparations of uric acid, which is a very remarkable and powerful photographic element. The intensity of the original negative picture is no criterion of what may be expected in the positive. It is from the production, by one and the same action of the light, of either a positive or a negative picture according to the subsequent manipulations, that I have designated the process, thus generally sketched out, by the term *amphitype*,—a name suggested by Mr. Talbot, to whom I communicated this singular result; and to this process or class of processes (which I cannot doubt when pursued will lead to some very beautiful results) I propose to restrict the name in question, though it applies even more appropriately to the following exceedingly curious and remarkable one, in which silver is concerned. At the last meeting I announced a mode of producing, by means of a solution of silver, in conjunction with ferro-tartaric acid (§ 52), a dormant picture brought out into a forcible negative impression by the breath or moist air. The solution then described, and which had, at that time, been prepared some weeks, I may here incidentally remark, has retained its limpidity and photogenic properties quite unimpaired during the whole year since elapsed, and is now as sensitive as

ever,—a property of no small value. Now, when a picture (for example an impression from an engraving) is taken on paper washed with this solution, it shows no sign of a picture on its back, whether that on its face be developed or not; but if, while the actinic influence is still fresh upon the face (*i. e.* as soon as it is removed from the light), *the back* be exposed for a very few seconds to the sunshine, and then removed to a gloomy place, a *positive picture, the exact complement of the negative one on the other side*, though wanting of course in sharpness if the paper be thick, *slowly and gradually makes its appearance* there, and in half an hour or an hour acquires a considerable intensity. I ought to mention that the 'ferro-tartaric acid' in question is prepared by precipitating the ferro-tartrate of ammonia (ammonio-tartrate of iron) by acetate of lead, and decomposing the precipitate by dilute sulphuric acid.

"When lead is used in the preparation of Amphitype paper, the parts on which the light has acted are found to be in a very high degree *rendered water-proof*."

57. In the preceding pages we have attempted to furnish the reader with the most remarkable and the most interesting photographic processes as applied to paper. We have purposely omitted a few, for the reason that they were but modifications of other processes, and their use was attended with no practical advantage. The full details respecting Daguerreotype, Thermography, &c., will be found in the Second Part of this Manual.

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